

# PATENT SPECIFICATION

NO DRAWINGS

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## COMPLETE SPECIFICATION

### Improvements in Processes for Heating and Melting by High Frequency Electrical Induction

We, L'ELECTRO-REFRACTAIRE, a French Body Corporate, of 39, Rue Cambon, Paris, Seine, France, do hereby declare the invention, for which we pray that a patent may 5 be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the induction heating of materials which have a low conductivity when cold, i.e. when at a room 10 temperature of about 15°C.

It is known in the metallurgical industry to heat, and where desired to melt, materials 15 by a process of high-frequency induction, which has the advantage of enabling the material to be evenly heated throughout its section.

Although some materials have a sufficiently 20 high conductivity to permit the inductive heating effect at high temperatures, their conductivity when cold is too low for them to be permeable to induced electrical currents. This applies *inter alia* to alumina, 25 zirconia and magnesia, from which refractory products are prepared, and also applies more particularly to oxides having a high melting point, such as uranium and thorium oxides, and all oxides which are not sufficiently 30 conductive until they reach a temperature within the range 1200 to 1800°C. It would be very desirable to use induction heating to melt such types of material.

To melt such materials in an induction 35 furnace it has been proposed to preheat them to the temperature at which they become conductive, for instance, by enclosing them in a highly conductive sleeve made of molybdenum or graphite, which sleeve is heated by high-frequency induction and heats in turn the material to be melted by radiation. The conductive sleeve is interposed between the field winding of the in-

duction coil and the crucible containing the material to be melted. The sleeve may be removed when the material enclosed therein is sufficiently hot to become inductively heated on its own account. It has also been proposed to initiate melting of such materials by a separate auxiliary heat source 50 such as electric arc. Such previously-proposed methods are however of a complicated nature.

The high-frequency induction heating and melting method according to the invention 55 is a relatively simple method, and dispenses with the inductive sleeve and/or any auxiliary heating current, other than the high-frequency current.

The invention consists of a method of 60 high-frequency induction heating or melting of a material which has little or no electrical conductivity in the cold state but which is capable of being inductively heated when hot, comprising associating with the said 65 material forming the main charge, an auxiliary charge of an additional substance which at the temperature at which the main charge material has little or no electrical conductivity, has sufficient electrical conductivity to be capable of being inductively heated, and which when hot undergoes an exothermic reaction in air; inductively heating the said auxiliary charge whereby the 70 said auxiliary charge undergoes an exothermic reaction with air and heats the said main charge material to a temperature at which it becomes sufficiently conductive to be inductively heated, and inductively heating the said main charge.

The said auxiliary charge can be deposited on the charge of material to be melted, or preferably in a cavity through, or in, the centre of the charge. The auxiliary charge is preferably a metal which when in the 85 heated state in contact with atmospheric

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oxygen becomes oxidized with the production of a great amount of heat. Particularly useful are powdered or granular elements such as aluminium, magnesium, zirconium and silicon.

It is desirable to select the auxiliary charge material, e.g. element, which in its final state after the exothermic reaction, is or is to be one of the constituents of the molten main charge, so as to avoid any pollution thereof by an undesirable element. It is also important to select an auxiliary charge material which does not react chemically during the initiating period with the main charge material melted.

As an example of the invention, a main charge of alumina was heated by high-frequency induction heating, by lining a small hole in the pulverulent charge of alumina with granular aluminium, whose purely exothermic oxidation allows the surrounding charge of alumina to be very rapidly heated to a temperature at which it becomes permeable to induced currents. The initiating auxiliary charge of aluminium produced alumina when heated to a sufficiently high temperature by induction heating, the heat of reaction raising the temperature of the combined masses of alumina sufficiently high for them to be further heated by induction heating.

The method according to the invention has the considerable advantage that it enables refractory oxides to be heated up to about 3000°C. Unlike external preheating methods, which cause considerable losses of induction current, the method according to the invention enables the charge of refractory oxides to be heated to very high temperatures which is necessary to melt, for instance, alumina and magnesia.

#### WHAT WE CLAIM IS:—

1. A method of high-frequency induction heating or melting of a material which has little or no electrical conductivity in the cold state but which is capable of being

inductively heated when hot, comprising associating with the said material forming the main charge, an auxiliary charge of an additional substance which at the temperature at which the main charge material has little or no electrical conductivity, has sufficient electrical conductivity to be capable of being inductively heated, and which when hot undergoes an exothermic reaction in air; inductively heating the said auxiliary charge whereby the said auxiliary charge undergoes an exothermic reaction with air and heats the said main charge material to a temperature at which it becomes sufficiently conductive to be inductively heated, and inductively heating the said main charge.

2. A method as claimed in Claim 1, in which the said auxiliary charge is deposited in the induction furnace on the said main charge.

3. A method as claimed in Claim 1, in which the said auxiliary charge is deposited in a cavity through or in the centre of the said main charge.

4. A method as claimed in any of Claims 1 to 3, in which the said auxiliary charge is a powdered or granular metal capable of undergoing an exothermic reaction when hot with air.

5. A method as claimed in Claim 4, in which the auxiliary charge is powdered or granular aluminium, zirconium, silicon, magnesium or uranium.

6. A method as claimed in any of Claims 1 to 5, in which the auxiliary charge is a metal whose oxide is the or a constituent of the main charge.

7. A high-frequency induction method of heating as claimed in Claim 1, substantially as hereinbefore described.

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